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(71) Applicant: OLYMPUS OPTICAL CO., LTD.
43-2, 2-chome, Hatagaya Shibuya-ku
Tokyo 151(JP)

(72) Inventor: Yoshida, Yutaka
c/o Nanyodai 71-4 1755-348, Horinouchi
Hachioji-shi Tokyo(JP)

(72) Inventor: Hirayama, Shozo
c/o Watanabe-So 2-1 1110-6, Sandahigashi-Cho
Hachioji-Shi Tokyo(JP)

(72) Inventor: Kusunoki, Hiroyuki
1-4-14, Aoba-Cho
Higashimurayama-Shi Tokyo(JP)

(72) Inventor: Shishido, Yoshio
c/o Sagamihara-Sukaihaitsu 512 2-1-30, Fuchinobe
Sagamihara-Shi Kanagawa-Ken(JP)

(72) Inventor: Matsuo, Kazumasa
3-1-7-304, Ochiai
Tama-Shi Tokyo(JP)

(72) Inventor: Mizumoto, Morihide
4-22-13, Owada-Cho
Hachioji-Shi Tokyo(JP)

(72) Inventor: Kato, Masahiko
37-3, Shimoyotsugi
Akikawa-Shi Tokyo(JP)

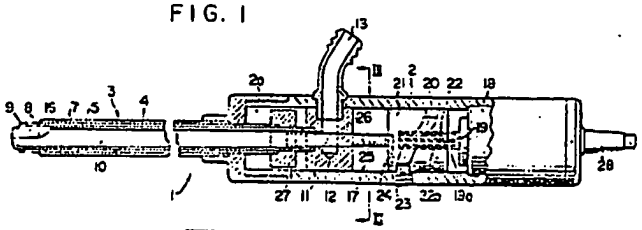
(72) Inventor: Hagino, Tadao
2-3-3, Rokkakubashi Kanagawa-Ku
Yokohama-Shi Kanagawa-Ken(JP)

(74) Representative: Jones, Colin et al,
W.P. THOMPSON & CO. Coopers Building Church Street
Liverpool L1 3AB(GB)

(54) **Surgical cutting instrument.**

(57) A surgical cutting instrument (1) essentially comprises an outer sheath tube (4), an inner stationary tube (5) which is disposed within said outer sheath tube (4) such that the distal end of the inner tube (5) projects from the distal end of the outer sheath tube (4) and is provided with a cutting opening (8) for drawing cut tissue chips at the peripheral wall of the distal end of the inner tube (5) and a sliding member (7) which is slidably disposed between said outer sheath tube (4) and said inner tube (5) so as to open and close said cutting opening (8) and is provided with an outer cutting edge (18) which engages an inner cutting edge (9) of said cutting opening (8), on the distal end edge of the sliding member (7), whereby a body tissue is cut by axially and slidingly reciprocating said sliding member (7) to open and close said cutting opening (8) and cut tissue pieces are withdrawn from the body by suction through a suction channel (10) of the inner tube (5).

FIG. 1



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DESCRIPTION

SURGICAL CUTTING INSTRUMENT

The present invention relates to a surgical cutting instrument, and more particularly, to a surgical cutting instrument capable of, while being inserted into a body cavity, particularly a joint cavity of the knee, for example, performing an easy and reliable cutting and evacuating operation of a cartilage, bone, fibrous tissue, tumor or the like.

A conventional operation of a joint generally employs an incision method (open surgery). By way of example, a commonly used operation of the knee such as to remove a tumor on the patella or to excise a damaged cartilage or a bone from the knee joint requires a large incision of an epithelium. The incision consequently provokes a trauma in the patient. Thus, the trauma will cause pain and limitations of movement. Furthermore, a considerable time is required for recovery from the trauma.

Accordingly, there has recently been proposed an instrument in which under observation with an arthroscope (endoscope), a small perforation is provided on an epithelium without incising the knee epithelium and an operation is effected inserting a probe into the perforation (closed surgery). For instance, such instruments are disclosed in US-A-4,203,444 and US-A-4,246,902.

The prior art instrument disclosed in US-A-4,203,444 comprises an elongate external stationary tube defining a side-facing, axially extending shaving port on the periphery of the external tube, an internal tube which is rotatably mounted within the external tube and defines an internal, rotary blade at the shaving port, a suction apparatus and a drive motor. The instrument severs tissue or the like by

rotating the rotary blade with the drive motor and draws shavings by suction to remove them through the internal member.

In the shaving port of a conventional instrument of the above construction, an outer cutting edge is formed on the inner periphery of the external tube and an inner cutting edge is formed by the rotary blade. In this arrangement the bite between the outer and the inner cutting edges is inefficient and it is difficult to aim at a tissue with the cutting instrument in a steady manner. In addition, since the cutting operation is effected only after a tissue is drawn in the shaving port of the external tube by means of the suction apparatus, it is difficult to cut a tissue such as a cartilage or a bone. To rotate the internal tube, which forms a suction channel therein, a rotary shaft passes through the suction channel and therefore cut or shaved tissue is not smoothly sucked and withdrawn.

The prior art instrument disclosed in US-A-4,246,902 comprises a probe-like outer, elongate member having a distal end with a cutting aperture in a side wall thereof, an inner cutting member which is slidably disposed within the outer member and has a distal end defining a cutting edge positioned at said distal end of the outer member, a suction apparatus and a drive mechanism for the inner cutting member. The instrument cuts a tissue, which is drawn by suction in the cutting aperture, by reciprocation of the inner cutting member and then the cut tissue is sucked and evacuated. The instrument thus constructed, however, has the disadvantages as indicated in the former prior art. Specifically, since the inner cutting member which is disposed within the outer member forms an inner cutting edge,

the bite between the outer member and the inner cutting edge is inefficient and it is difficult to aim at a tissue with the cutting instrument in a steady manner. In addition, it is difficult to cut a comparatively hard tissue such as a cartilage or bone. Since the inner cutting member is slidably disposed within a suction channel passage, cut tissue is not smoothly sucked and withdrawn.

It is an object of the invention to provide a surgical cutting instrument which is easy to aim at a tissue in a steady manner.

It is another object of the invention to provide a surgical cutting instrument whose cutting edges have an efficient bite.

According to the present invention, there is provided a surgical cutting instrument including an inserter having a cutting opening adjacent to the periphery of the distal end of the inserter, a movable cutting member provided with a cutting edge which co-operates with said cutting opening and a suction channel which communicates with said cutting opening and passes through said inserter, whereby a piece of tissue which is introduced into said cutting opening and is cut by said cutting edge is discharged by suction through said suction channel, characterized in that an outer sheath tube, which has an open distal end, is secured to a grip at the proximal end of the outer sheath tube; in that an inner stationary tube which has a closed distal end, is disposed within said outer sheath tube such that the distal end of said inner tube projects from the open distal end of said outer tube and is secured to said grip at the proximal end of the inner tube; in that said cutting opening is provided on the peripheral wall of said projected distal end of said inner stationary tube so as to form

an inner cutting edge on the edge of said cutting opening; in that said cutting member is a sliding member which is slidably disposed between said outer sheath tube and said inner stationary tube such that the distal end of said sliding member opens and closes said cutting opening and which is provided with the outer cutting edge which co-operates with said inner cutting edge of said cutting opening on the distal end edge of the sliding member; in that drive means are provided for axially and slidingly reciprocating said sliding member to open and close said cutting opening; and in that suction and discharge means are connected to said inner stationary tube to communicate therewith for effecting the suction operation through a suction channel of said inner stationary tube.

Since no other member such as a rotary shaft passes through the suction passage and the suction passage body itself does not reciprocate or rotate, cut or shaved tissue pieces can be smoothly sucked and evacuated.

In addition, since the cutting opening for drawing tissue is provided at an easily visible position on the distal end of the instrument, it is possible to easily take accurate aim at a tissue which is to be removed. Thus, the cutting operation is reliably limited to the affected tissue which is to be cut or shaved.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:-

Fig.1 is a cross-sectional view of essential parts of one embodiment of a surgical cutting instrument according to the invention;

Figs. 2(A) to 2(D) are enlarged plan views of essential parts of respective examples of cutting

openings for withdrawing tissue in the surgical cutting instrument shown in Fig.1;

Fig.3 is a cross-sectional view taken on line III-III in Fig.1;

Fig.4 is a plan view illustrating essential parts of a drive mechanism for a sliding member shown in Fig.1; and

Fig.5 is a schematic view illustrating an example of the set-up for performing the joint operation using the surgical cutting instrument shown in Fig.1.

Referring to Fig.1, a surgical cutting instrument 1 comprises a grip 2 at its proximal side and an elongate inserter 3 forwardly extending from the grip 2 (left in Fig.1) and which is inserted into a body cavity, such as a joint cavity. The inserter 3 comprises an outer sheath tube 4 which has an open distal end and an open proximal end, the latter of which ends is secured to the distal end of the grip 2, an inner stationary tube 5 which is disposed within the outer sheath tube 4 such that a closed distal end of the inner tube 5 projects from the open distal end of the outer sheath tube 4 and a sliding member 7 which is in a close sliding fit between the inner periphery of the outer sheath tube 4 and the outer periphery of the inner tube 5 so as to be axially slidable.

The inner tube 5 is provided on the outer periphery of its distal end with a cutting opening which projects from the distal end of the outer sheath tube 4. An inner cutting edge 9 is defined on the edge of the cutting opening 8. In addition, the inner tube 5 forms a suction channel 10 for withdrawing cut pieces of tissue passing through the inner tube which communicates with the cutting opening 8. The proximal end of the inner tube 5 is secured to a stationary

member 11 which is fitted into the grip 2. The stationary member 11 has a passage 12 which communicates with the suction channel 10 and which further communicates with a fitting 13 which is threadably fitted into the stationary member 11 on the outer periphery of the grip 2. The fitting 13, as shown in Fig.5, communicates with a suction and discharge apparatus 15 through a tube 14 whose one end is connected to the fitting 13 and whose other end is connected to the suction and discharge apparatus 15. The cutting opening 8 of the inner tube 5 may have a number of advantageous shapes as shown in Figs. 2(A) to 2(D), for example. The cutting opening 8 of Fig.2(A) is in an axially elongated square shape. The cutting opening 8A of Fig.2(B) is in a circumferentially extended square form and has the advantage that the extent of projection of the distal end of the inner tube 5 from the distal end of the outer sheath tube 4 can be reduced. The cutting opening 8B of Fig.2(C) is in a triangular shape whose front side is the distal end edge of inner tube 5. The cutting opening 8C of Fig.2(D) is in a triangular shape, one vertex of which is at the distal end of the inner tube 5.

Referring back to Fig.1, the sliding member 7 is formed of a tube, the distal end of which is provided with an outer cutting edge 16 which engages the inner cutting edge 9 of the cutting opening 8 and closes the cutting opening 8 when moved forwardly and opens the cutting opening 8 when moved backwardly. The proximal end of the sliding member 7 is inserted into a hollow chamber 2a of the grip 2 and is connected to a drive transmitter 17 which is disposed within the hollow chamber 2a. The drive transmitter 17 includes an output shaft 19 of a drive motor 18 and a cylindrical

cam 21 having a circumferentially extended and longitudinally inclined cam groove 20 on the outer periphery of the cam 21. The output shaft 19 and the cam 21 are engaged with each other by means of a spline 19a of the shaft 19 and a spline 22a of the cam 21. In addition, a fixed cam guide pin 23 is fitted into the cam groove 20 so that the cam 21 can be rotatably and slidably moved along the cam groove 21. A slidable shaft 25 is inserted into a rotary centre hole 24 provided on the front of the cam 21 for journalling the shaft 25 and for preventing the shaft 25 from rotating. The slidable shaft 25, as best shown in Fig.4, has two forked shafts 25a which respectively pass through through-holes 26 (see Fig.3), which are axially provided at the right and left positions of the stationary member 11. The distal ends of the forked shafts 25a are secured to a slidable attachment 27 which is disposed at the proximal end of the inner tube 5 so as to be axially slidable within the hollow chamber 2a. The slidable attachment 27 to which the proximal end of the sliding member 7 is secured is moved back and forth so that the sliding member 7 can be integrally and axially moved with the slidable attachment 27.

The drive motor 18 is electrically connected to a motor controller 29 (see Fig.5) through a cable 28 which is extended from the grip 2. The revolution of the motor 18 is controlled by a current, voltage or frequency employing an on-off or a speed controller with an at hand switch provided on the grip 2.

The operation of the surgical cutting instrument 1 will be explained with reference to Fig.5. To cut a body region such as tissue of the knee joint, a small perforation into which the inserter 3 of the instrument 1 is inserted is provided on the knee 30 by

a puncture operation as by a trocar. The inserter 3 is then inserted into the joint cavity directly or through a trocar. Prior to the insertion of the inserter 3, an inserter 32 of an arthroscope 31, in which an illumination and observation optical system is disposed, is inserted into the joint cavity by a puncture operation as by a trocar so as to permit the cutting operation of tissue to be effected under observation of the inside of the joint cavity. The inside of the joint cavity and the inserter 3 inserted thereinto can be made observable by an eyepiece of the arthroscope 31 directly or through a display 34 which displays a visual image of a television camera 33 mounted on the eyepiece. Furthermore, to facilitate the cutting operation by inflating the inside of the joint cavity, a physiological solution of sodium chloride is supplied from a solution supplier 35 into the joint cavity with a controlled pressure through a water supply tube 36 which is inserted into the joint cavity. On the other hand, the tube 14 is connected to the fitting 13 on the grip 2 and is further connected to the suction and discharge apparatus 15. A connector (not shown) of the cable 28 is connected to the motor controller 29 to supply power to the motor 18.

Under these circumstances, an operator causes the cutting opening 8 to bear against tissue which is to be cut while observing the inside of the joint cavity and the distal end of the inserter 3 with an arthroscope or the display 34 so as to introduce the tissue into the cutting opening 8. Under this condition, a switch is turned on to drive the motor 18. The drive force of the motor 18 actuates the sliding member 7 to axially and slidingly reciprocate it through the drive transmitter 17 so that the outer

cutting edge 16 engages the inner cutting edge 9 of the cutting opening 8 to cut or shave the tissue introduced in the cutting opening 8. The tissue pieces thus cut are discharged into the suction and discharge apparatus 15 by suction through the suction channel 10, which communicates with passage 12 of the stationary member 11, with fitting 13 and tube 14. The suction and discharge apparatus 15 is activated when necessary or normally.

A means for converting the rotary force of the motor to the reciprocating motion to move the sliding member 7 back and forth may be not only the means of the aforesaid embodiment, but also one of other various well known means. In addition, in the aforesaid embodiment, the sliding member 7 is illustrated by a tubular body but may be formed with a tubular body merely at the distal end portion of the sliding member 7 on which the outer cutting edge 16 is defined. Alternatively, the sliding member 7 need not be in a tubular shape when it has such width and shape that the distal end portion of the sliding member 7 can close the cutting opening 8. Furthermore, the proximal side of the sliding member 7 may be of any tubular, ring or plate shape.

In the surgical cutting instrument of the invention, the cross sectional form of the inserter 3 may be of any circular, elliptical, rectangular or triangular shape. The sliding member 7 may be reciprocated axially with a manual operation (means for moving the sliding member back and forth by a cruciform handle, a lever or the like). It is to be noted that the surgical cutting instrument of the invention can be applied to not only the excising operation of tissue of the joint cavity, but also that of another body cavity.

CLAIMS

1. A surgical cutting instrument (1) including an inserter (3) having a cutting opening (8) adjacent to the periphery of the distal end of the inserter (3), a movable cutting member (7) provided with a cutting edge (16) which co-operates with said cutting opening (8) and a suction channel (10) which communicates with said cutting opening (8) and passes through said inserter (3), whereby a piece of tissue which is introduced into said cutting opening (8) and is cut by said cutting edge (16) is discharged by suction through said suction channel (10), characterized in that an outer sheath tube (4), which has an open distal end, is secured to a grip (2) at the proximal end of the outer sheath tube (4); in that an inner stationary tube (5) which has a closed distal end, is disposed within said outer sheath tube (4) such that the distal end of said inner tube (5) projects from the open distal end of said outer tube (5) and is secured to said grip (2) at the proximal end of the inner tube (5); in that said cutting opening (8) is provided on the peripheral wall of said projected distal end of said inner stationary tube (5) so as to form an inner cutting edge (9) on the edge of said cutting opening; in that said cutting member is a sliding member (7) which is slidably disposed between said outer sheath tube (4) and said inner stationary tube (5) such that the distal end of said sliding member opens and closes said cutting opening (8) and which is provided with the outer cutting edge (16) which co-operates with said inner cutting edge (9) of said cutting opening (8) on the distal end edge of the sliding member; in that drive means (17) are provided for axially and slidingly reciprocating said sliding member (7) to open and close said cutting opening

(8); and in that suction and discharge means (15) are connected to said inner stationary tube (5) to communicate therewith for effecting the suction operation through a suction channel (10) of said inner stationary tube (5).

2. A surgical cutting instrument as claimed in claim 1, in which said inner stationary tube (5) has a proximal end which is fixed to a stationary member (11) which is disposed within said grip (2) so as to communicate with said suction and discharge means (15) through a communicating passage (12) provided within said stationary member (11) and a fitting (13) which is fitted into said stationary member.

3. A surgical cutting instrument as claimed in claim 1 or 2, in which said cutting opening (8) is rectangular in shape, being elongated in the axial direction of said inner tube (5).

4. A surgical cutting instrument as claimed in claim 1 or 2, in which said cutting opening (8A) is in a rectangular shape elongated in the circumferential direction of said inner tube (5).

5. A surgical cutting instrument as claimed in claim 1 or 2, in which said cutting opening (8B) is in a triangular shape whose one side is the distal end edge of said inner tube (5).

6. A surgical cutting instrument as claimed in claim 1 or 2, in which said cutting opening (8C) is in a triangular shape whose one vertex is at the distal end of said inner tube (5).

7. A surgical cutting instrument as claimed in any of claims 1 to 6, in which said sliding member (7) is formed with a tubular body and is disposed between the inner peripheral surface of said outer sheath tube (4) and the outer peripheral surface of said inner tube (5) in a close sliding fit.

8. A surgical cutting instrument as claimed in any of claims 1 to 7, in which said drive means (17) comprises a drive motor (18), a cylindrical rotatable cam (21) which is connected through a spline mechanism (19a, 22a) to an output shaft (19) of said motor (18) and is movable back and forth while rotating through a cam mechanism (20, 23), a slidable shaft (25) in a forked shape whose proximal end is journalled in said cylindrical cam (21) so as to be axially slidable with said cylindrical cam (21) while permitting the latter to be rotated and a slidable attachment (27) to which said slidable shaft (25) is fixed and which is fixed to the proximal end of said sliding member (7).

9. A surgical cutting instrument as claimed in claim 8, in which said cam mechanism comprises a cam groove (20) in a spiral form which is provided on the outer peripheral surface of said cylindrical cam (21) and a cam guide pin (23) which is fixedly provided on said grip (2) and is fitted into said cam groove (20).

10. A surgical cutting instrument as claimed in claim 8 or 9, in which said slidable shaft (25) has forked stems (25a) passing through through-holes (26) which are provided in said stationary member (11) such that said slidable shaft (25) is prevented from rotating.

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FIG. 1

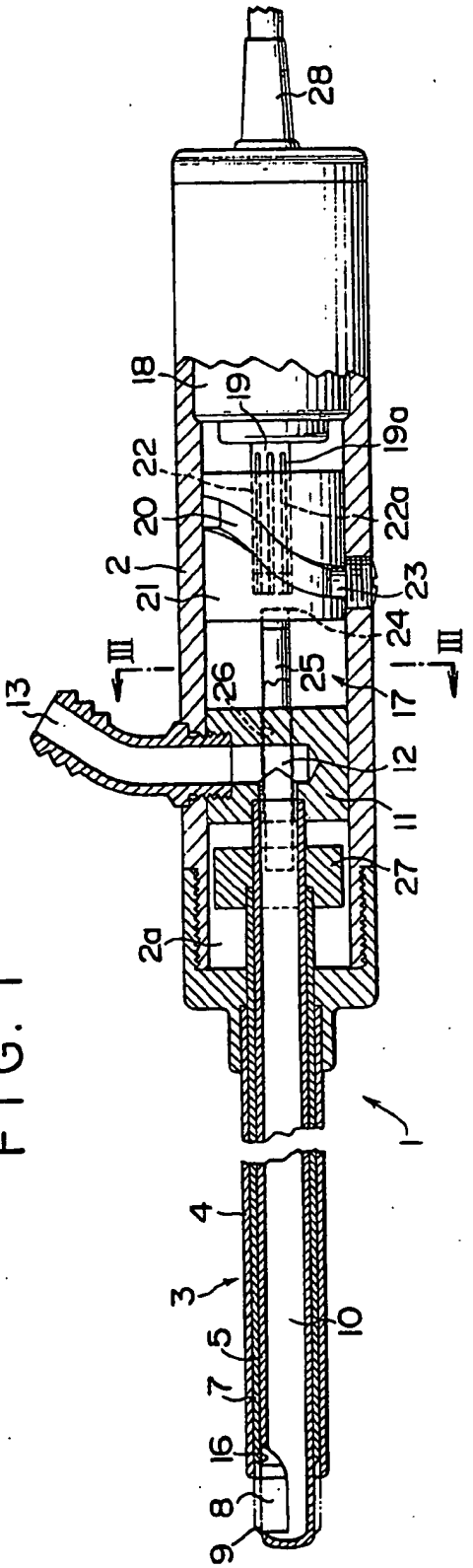

FIG. 2D

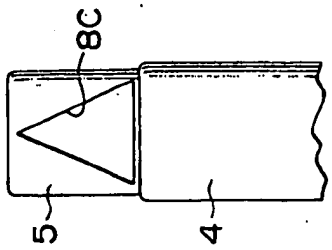

FIG. 2C

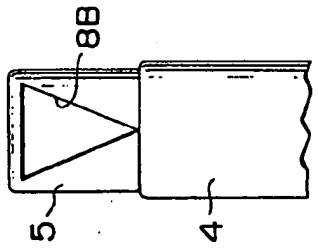

FIG. 2B

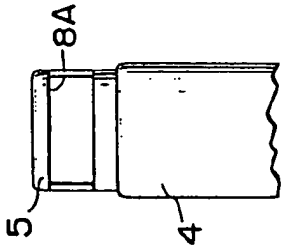

FIG. 2A

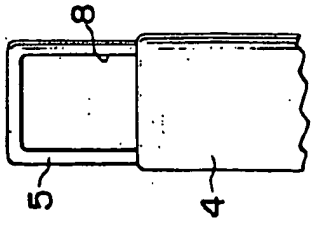

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FIG. 3

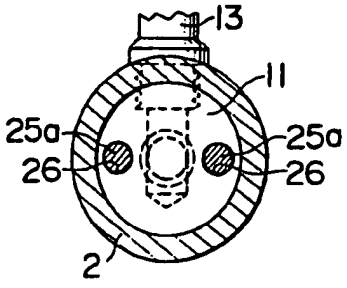


FIG. 4

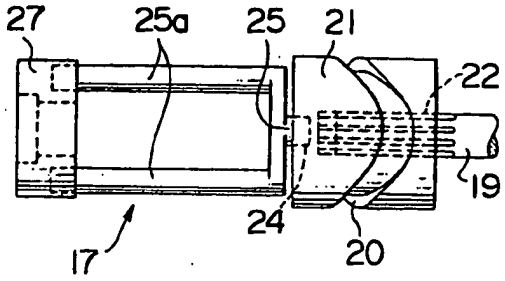
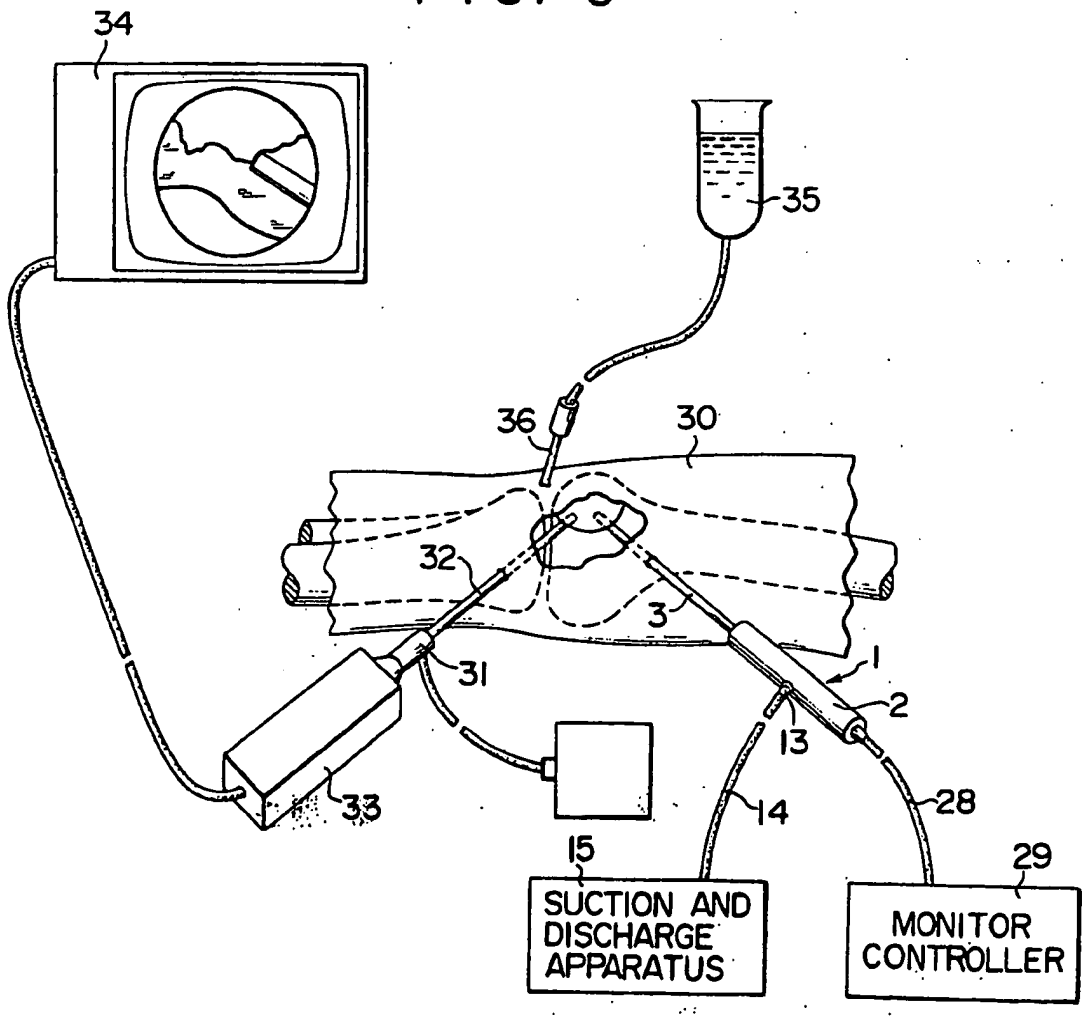


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 6845

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-5 112 302 (R. CUCIN)	1	A61M1/00
A	EP-A-0 125 070 (OLYMPUS OPTICAL CO LTD)	1	
A	FR-A-2 648 050 (P BOUVIER)	1	
A	DE-C-330 284 (A MEYENBERG)	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

A61M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 February 1995	Vereecke, A

CATEGORY OF CITED DOCUMENTS

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